



Sociobiology

An international journal on social insects

SHORT NOTE

A note on the karyotype and morphology of the ant *Platythyrea sinuata* (Roger, 1860) (Formicidae, Ponerinae, Platythyreini)

PNC SILVA-ROCHA¹, JPSO CORREIA¹, CSF MARIANO^{1,2}, JHC DELABIE², MA COSTA¹

1- Universidade Estadual de Santa Cruz (UESC), Ilhéus-BA, Brazil

2- Laboratório de Mirmecologia, Centro de Pesquisas do Cacau (CEPEC/CEPLAC), Itabuna-BA, Brazil

Article History

Edited by

Gilberto M. M. Santos, UEFS, Brazil

Received 22 June 2017

Initial acceptance 15 August 2017

Final acceptance 20 August 2017

Publication date 27 December 2017

Keywords

Cytotaxonomy; CMA₃/DAPI; Chromosomal heteromorphism; Phenotype.

Corresponding author

Patrícia Nayara Caldas Silva Rocha
 Departamento de Ciências Biológicas
 Universidade Estadual de Santa Cruz
 Km 16 Rodovia Ilhéus-Itabuna
 CEP 45650-000, Ilhéus-BA, Brasil.
 E-Mail: patinay9@gmail.com

Abstract

Taxonomy of the genus *Platythyrea* is confusing because of high phenotypic plasticity, possible synonymies and morphological proximity to other species of this genus. The correct identification of *Platythyrea sinuata* can be achieved using integrative taxonomy including both morphological and genetic components. Here we describe the karyotype of *P. sinuata*, which has 2k=24M+20A with CMA₃⁺/DAPI⁺ on a single chromosome of the haploid set. These data will help to clarify the taxonomic status of this species.

The Platythyreini Emery, 1901 includes the genus *Platythyrea* Roger, 1863. This Pantropical genus is composed of 38 species, 13 of which are Neotropical, including four fossil species (Bolton, 2017). Identifying species and characterizing the diversity of *Platythyrea* is not a simple task, because it is a genus with homogeneous morphological characters and it has a relatively high phenotypic plasticity (Brown, 1975). Despite the revision of Brown (1975), there is still much to be clarified about this genus.

Platythyrea sinuata (Roger, 1860) has Suriname as type-locality, and is found in with a wide geographic distribution in forests of South America. According to Brown (1975), *P. sinuata* has two synonyms, *Platythyrea meinerti* Forel, 1905 and *Platythyrea meinerti boliviana* Santschi, 1921, due to its phenotypic variation. However, the taxonomic description of *P. sinuata* still leaves doubts and needs more information. The precise identification of this and other species of this

genus would be facilitated by integrative studies combining morphology, molecular and cytogenetic data, given the limitations of classical taxonomic characters (Schlick-Steiner et al., 2010).

Karyotype characters are useful for taxonomic and evolutionary studies. To date, more than 125 morphospecies of Ponerinae ants had their karyotype data studied, with chromosome numbers varying from 2n = 8 to 120 (Lorite & Palomeque, 2010; Mariano et al., 2015; Correia et al., 2016). However, cytogenetic studies with *Platythyrea* are restricted and only four species had their chromosomal numbers identified: *Platythyrea quadridenta* Donisthorpe, 1941, 2n (n) = 18 (9) and *Platythyrea tricuspidata* Emery, 1900, 2n = 92-96 (Imai et al., 1983; 1990) from Malaysia, *Platythyrea pilosula* (Smith, 1858), 2n = 40 (Mariano et al., 2015) from French Guiana and *Platythyrea punctata* (Smith, 1858), 2n = 84 from Central America (Schilder, 1999).



In this context we present a cytogenetic description and notes on the morphology of *P. sinuata* carried out in samples of a colony found in the Brazilian Atlantic Forest. It is noteworthy that this relatively common species in the Amazon region is surprisingly very rare in the Atlantic Forest, as well as two other species of this genus (Delabie, 2001). Our data will be useful for understanding the taxonomic status and evolution of this species in further integrative studies on *Platythyrea*.

The *P. sinuata* colony was collected in cabruca area (name given to cocoa plantation in native forest understory), between rotted trunk and soil in Ilhéus, Bahia State, Brazil (14°47'51"S, 39°02'13"W). Adult workers were identified following Brown (1975). Vouchers were deposited in the Collection of the Laboratory of Mirmecology, at the Centro de Pesquisa do Cacau, CEPEC-CEPLAC, in Ilhéus, Bahia, Brazil.

Specimens were photographed under a Leica M165C stereomicroscope. Morphometric measurements were performed to an accuracy of 0.01 mm following the terminology of Brown (1975).

The colony was maintained in a B.O.D. incubator at 28°C to obtain larvae for cytogenetic analysis. Metaphases were prepared from prepupae cerebral ganglion, following Imai et al. (1988), after 40 minutes treatment in colchicine (0.005%). The slides were then stained with 3% Giemsa solution and analyzed under an Olympus CX41 equipped with a digital camera. A minimum of 10 metaphases was analyzed for each specimen. Chromosomes were classified following Levan et al. (1964) and the karyograms were organized using Adobe Photoshop® 7.

Chromomycin A₃ (CMA₃) and 4'-6-diamidino-2-phenylindole (DAPI) staining for the characterization of chromosomal segments rich in CG and AT base pairs, respectively, followed Guerra and Souza (2002). Metaphases images were captured with software Image Pro Plus® version 4.1 (Media Cybernetics) in an Olympus BX51 microscope.

The specimens had predominantly brown opaque coloration (Fig 1A-F); moderately large eyes 0.31-0.34 (0.33 mm) (Fig 1A, C-D); in lateral view, a curved groove (directed from the dorsal to lateral margin) not developed, present at the base of the mandible (Fig 1D); in side view, long mesosome with Weber length 2.89-3.01 (2.99 mm); in side view, a slope of propodeum with a tooth on the front side; in dorsal view relatively long and narrow petiole, forming a tooth in the postero-medial region; femur of the first leg about twice as wide as the femur of the 2nd leg 0.43-0.46 (0.45 mm) (Fig 1A).

The identification key for *Platythyrea* of the New World by Brown (1975) comprises few diagnostic characters considering the high variation in size, shape and color patterns in the species of this group. *Platythyrea sinuata* exhibits a great morphological similarity with *Platythyrea angusta* Forel, 1901, *P. pilosula* and *P. punctata* making its correct identification difficult (Brown, 1975).

In Formicidae discrete phenotypic variations observed are not always to be considered as useful characteristics for

the separation of populations into distinct species, and may be only the reflection of geographic or ecological variations (Lucas et al., 2002; Fedoseeva, 2011).

As *P. sinuata* has a wide geographical distribution and explores different habitats the best way to correctly identify possible cryptic species would be to analyze the greatest amount of data available (Seifert, 2009; Heled & Drummond, 2010), mainly due to its phenotypic plasticity, which hinders classical taxonomic approaches.

Platythyrea sinuata had $2n=44$ chromosomes, with karyotypic formula $2k=24M+20A$ (Fig 2). A length heteromorphism occurs in the first chromosome pair. Imai et al. (1983) reported a large difference in the chromosome number of two Malaysian species *P. quadridenta* and *P. tricuspidata* showed, $2n=18$ and $2n=96$, respectively. In the Neotropics (French Guiana), Mariano et al. (2015), reported



Fig 1. *Platythyrea sinuata*: (A) side view; (B) dorsal view; (C) head in front view; (D) head in side view; (E) mesosome in lateral view; (F) petiole in lateral view.

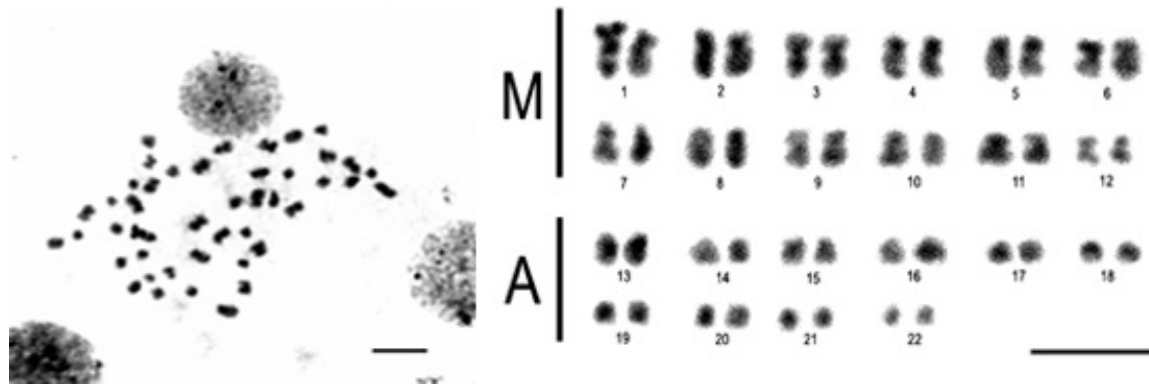


Fig 2. Metaphase and karyotype of *Platythyrea sinuata*. Bar = 10 μ M.

the chromosome number $2n=40$ for *P. pilosula*, while *P. punctata* of Central America, showed $2n=84$ (Schilder, 1999). This variation is significant considering the small number of karyotypes known for *Platythyrea* to date. Although the greatest variation was found among Malaysian species ($2n=18$, $2n=96$) high and intermediate numbers were reported in Central America and South America, respectively.

Platythyreini (*Platythyrea*) comprises a monophyletic group according to Schmidt (2013), with low chromosome numbered *P. quadridenta* positioned basally compared to *P. punctata* ($2n = 84$). The inclusion of cytogenetic data from more taxa will allow drawing important conclusions about the genus karyotypic evolution.

The fluorochrome staining showed a single marking, $CMA_3^+/DAPI^-$ in a single chromosome of the 1st pair, which coincides with a secondary constriction and length heteromorphism (Fig 3). Secondary constriction and $CMA_3^+/DAPI^-$ markings, consistently coincided with the nucleolar organizer region (NORs) in several other species, and indicates that the heteromorphism of *P. sinuata* is related to the variation in NORs length. Length heteromorphism was observed in other

ants such as *Pheidole* Westwood, 1839, and in *Temnothorax rugatulus* (Emery, 1895) (Taber & Cokendolpher, 1988).

The morphological and cytogenetic characterization of *Platythyrea sinuata* presented here will be useful for future taxonomic revision of the genus and in evolutionary studies, involving the establishment of phylogenetic relationships among species.

Acknowledgments

The authors thank José Raimundo Maia dos Santos and José Crispim Soares do Carmo for their help in field work and FAPESB for the study grant of the first author (PNCSR). CSFM, JHCD and MAC are CNPq Productivity Fellows.

References

- Bolton, B. (2017). An Online Catalog of the Ants of the World, Version 12 fevereiro 2017, <http://www.antcat.org/catalog/430140?qq=Platythyrea>.
- Brown Jr., W. L. (1975). Contributions toward a reclassification of the Formicidae. Part V. Ponerinae, Tribes Platythyreini, Cerapachyini, Cyliindromyrmecini, Acanthostichini, and Aenictogitini. *Entomology*, 5: 1-115.
- Correia, J. P. S. O., Mariano, C. S. F., Delabie J. H. C., Lacau, S. & Costa, M. A. (2016). Cytogenetic Analysis of *Pseudoponera stigma* and *Pseudoponera gilberti* (Hymenoptera: Formicidae: Ponerinae): a Taxonomic Approach. *Florida Entomologist*, 99: 718-721. doi: 10.1653/024.099.0422
- Delabie, J. H. C. (2001). New range of the Brazilian endemic *Platythyrea exigua* (Hymenoptera: Formicidae: Platythyreini). *Revista de Biologia Tropical*, 49: 1282.
- Donisthorpe, H. (1941). Descriptions of new species of ants from New Guinea. *Annals and Magazine of Natural History*, 7: 129-144.
- Emery, C. (1895). Beiträge zur Kenntniss der nordamerikanischen Ameisenfauna. (Schluss). *Zoologische Jahrbücher. Abteilung für Systematik, Geographie und Biologie der Tiere*, 8: 257-360



Fig 3. Metaphase of *Platythyrea sinuata* showing $CMA_3^+/DAPI^-$ band indicated by the arrow. Bar = 10 μ M.

- Emery, C. (1900). Formiche raccolte da Elio Modigliani in Sumata, Engano e Mentawai. Dummy reference. Annali Del Museo Civico di Storia Naturale, 20: 661-722.
- Emery, C. (1901). Notes sur les-sous-familles des Dorylines et Ponérines (Famille des Formicidae). Annales de la Société Entomologique de Belgique, 45: 32-54.
- Fedoseeva, E. B. (2011). Morphometric characteristics of *Formica aquilonia* ants in monitoring of their settlements. Entomological Review, 91: 152-168. doi: 10.1134/S0013873811020047
- Forel, A. (1901). Nouvelles espèces de Ponerinae. (Avec un nouveau sous-genre et une espèce nouvelle d'Eciton). Revue Suisse de Zoologie, 9: 325-353.
- Forel, A. (1905). Miscellanea myrmécologiques II. Annales de la Société Entomologique de Belgique, 49: 155-185.
- Guerra, M. S. & Souza, M. J. (2002). Como observar cromossomos: um guia de técnicas em citogenética vegetal, animal e humana. Ribeirão Preto, São Paulo, Brazil.
- Heled, J. & Drummond, A. J. (2010). Bayesian inference of species trees from multilocus data. Molecular Biology and Evolution, 27: 570-580. doi: 10.1093/molbev/msp274
- Imai, H. T., Brown Jr., W. L., Kubota, M., Yong, H-S & Tho, Y. P. (1983). Chromosome Observations on Tropical Ants from Western Malaysia. Annual Reports of National Institute of Genetics, 34: 66-69.
- Imai, H. T., Taylor, R. W., Crosland, M. W. J. & Crozier, R. H. (1988). Modes of spontaneous chromosomal mutation and karyotype evolution in ants with reference to the minimum interaction hypothesis. Japanese Journal of Genetics, 63: 159-185.
- Imai, H. T., Taylor, R. W., Kubota, M., Ogata, K. & Wada, M. Y. (1990). Notes on the remarkable karyology of the primitive ant *Nothomyrmecia macrops*, and of the related genus *Myrmecia* (Hymenoptera: Formicidae). Psyche: a journal of entomology. 97: 1-8.
- Levan, A., Fredga, K. & Sonberg, A. (1964). Nomenclature for centromeric position on chromosomes. Hereditas, 52: 201-220.
- Lorite, P. & Palomeque, T. (2010) Karyotype evolution in ants (Hymenoptera: Formicidae), with a review of the known ant chromosome numbers. Myrmecological News, 13: 89-102
- Lucas, C., Fresneau, D., Kolmer, K., Heinze, J., Delabie, J.H.C. & Pho, B. (2002). A multidisciplinary approach to discriminating different taxa in the species complex *Pachycondyla villosa* (Formicidae). Biological Journal of the Linnean Society, 75: 249-259. doi: 10.1046/j.1095-8312.2002.00017.x
- Mariano, C. S. F., Santos, I. S., Silva, J. G. da, Costa, M. A. & Pompolo, S. G. (2015). Citogenética e Evolução do cariótipo em formigas poneromorfas. In: Delabie, J. H. C. et al. As formigas poneromorfas do Brasil. Ilhéus: Editus, p. 103-125.
- Moure, J. S. (1950). Notas sobre alguns Meliponinae bolivianos (Hymenoptera, Apoidea). Dusenía, 1: 70-80.
- Roger, J. (1860). Die Ponera-artigen Ameisen. Berliner Entomologisch Zeitschrift, 4: 287-312.
- Roger, J. (1863). Die neu aufgeführten Gattungen und Arten meines Formiciden-Verzeichnisses nebst Ergänzung einiger früher gegebenen Beschreibungen. Berliner Entomologisch Zeitschrift, 7: 131-214.
- Santschi, F. (1921). Ponerinae, Dorylinae et quelques autre formicides néotropiques. Bulletin de la Société Vaudoise des Sciences Naturelles, 54: 81-103.
- Schilder K. (1999). "Safer without sex?" Thelytokous parthenogenesis and regulation of reproduction in the ant *Platythyrea punctata*. Master Dissertation. Julius-Maximilians-Universität, Würzburg, p. 1-160.
- Schmidt, C. A. (2013). Molecular phylogenetics of Ponerine ants (Hymenoptera: Formicidae: Ponerinae). Zootaxa, 3647: 201-250. doi: 10.11646/zootaxa.3647.2.1
- Schlick-Steiner, B. C., Steiner, F. M., Seifert, B., Stauffer, C., Christian, E. & Crozier, R. H. (2010). Integrative taxonomy: A multisource approach to exploring biodiversity. Annual Review of Entomology, 55: 421-438. doi: 10.1146/annurev-ento-112408-085432
- Seifert, B. (2009). Cryptic species in ants (Hymenoptera: Formicidae) revisited: we need a change in the alpha-taxonomic approach. Myrmecological News, 12: 149-166.
- Smith, F. (1858). Catalogue of hymenopterous insects in the collection of the British Museum. Part VI. Formicidae. London: British Museum, 216 pp.
- Taber, S. W. & Cokendolpher, J. C. (1988). Karyotypes of a Dozen Ant Species from the Southwestern U.S.A. (Hymenoptera: Formicidae). Caryologia, 41: 93-102.
- Westwood, J. O. (1839). An introduction to the modern classification of insects; founded on the natural habits and corresponding organisation of the different families. Volume 2. Part XI. London: Longman, Orme, Brown, Green and Longmans, pp. 193-224.

